

THAT WHICH IS CLAIMED IS:

1. A method of bonding two components, the method comprising:
positioning the components relative to one another to obtain a desired
5 orientation; and
bonding the two components in the desired orientation with metal
wherein a temperature of both components is maintained below a melting
temperature of the metal while bonding wherein bonding comprises plating
the metal on the two positioned components.
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2. A method according to Claim 1 wherein a first one of the
components comprises a substrate and wherein a second one of the
components comprises an optical component.
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3. A method according to Claim 1 wherein bonding comprises
electroplating the metal on the two components.
4. A method according to Claim 1 wherein bonding comprises
electroless plating the metal on the two components.
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5. A method according to Claim 1 wherein bonding comprises providing
an electrophoretic coating on the two components wherein the electrophoretic
coating comprises the metal and dielectric particles.
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6. A method according to Claim 1 wherein bonding comprises providing
particles of the metal on the two components and bonding the metal particles.
7. A method according to Claim 6 wherein each of the particles of the
metal comprises a dielectric material coated with the metal.
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8. A method according to Claim 6 wherein bonding the metal particles
comprises allowing diffusion between the metal particles.

9. A method according to Claim 8 wherein the metal comprises a metal having a relatively high diffusion rate at room temperature.

10. A method according to Claim 9 wherein the metal comprises
5 Indium.

11. A method according to Claim 8 wherein providing the particles of
the metal comprises providing the particles of the metal with a dielectric
coating thereon and wherein bonding the metal particles is preceded by
10 rupturing the dielectric coatings.

12. A method according to Claim 11 wherein rupturing the dielectric
coatings comprises passing an electric current through the particles.

15 13. A method according to Claim 8 wherein the metal comprises a first
metal with a first rate of diffusion and wherein the particles comprise a coating
of a second metal with a second rate of diffusion wherein the second rate of
diffusion is lower than the first rate of diffusion.

20 14. A method according to Claim 13 wherein the first metal comprises
Indium and the second material comprises Copper.

25 15. A method according to Claim 8 wherein providing the particles of
the metal comprises providing the particles of the metal with a coating of a
solid material that sublimes at a bonding temperature less than the melting
temperature of the metal.

16. A method according to Claim 15 wherein the solid material
comprises one of naphthalene or carbon dioxide.

30 17. A method according to Claim 8 wherein providing the particles of
the metal comprises providing the particles of the metal with a diffusion barrier
thereon and wherein bonding the metal particles is preceded by rupturing the
diffusion barrier.

18. A method of bonding two components, the method comprising:
positioning the components relative to one another to obtain a desired
orientation; and

5 bonding the two components in the desired orientation with metal
wherein a temperature of both components is maintained below a melting
temperature of the metal while bonding;

 wherein bonding comprises providing particles of the metal on the two
components and bonding the metal particles; and

10 wherein providing the particles of the metal comprises vibrating the
metal particles apart from the components, and after positioning the
components, applying the metal particles to the components.

19. A method of bonding two components, the method comprising:

15 positioning the components relative to one another to obtain a desired
orientation; and

 bonding the two components in the desired orientation with metal
wherein a temperature of both components is maintained below a melting
temperature of the metal while bonding;

20 wherein bonding comprises providing particles of the metal on the two
components and bonding the metal particles; and

 wherein bonding the metal particles comprises passing an electrical
current through the metal particles sufficient to weld interfaces thereof.

25 20. A method of bonding two components, the method comprising:

 positioning the components relative to one another to obtain a desired
orientation; and

 bonding the two components in the desired orientation with metal
wherein a temperature of both components is maintained below a melting
30 temperature of the metal while bonding;

 wherein bonding comprises providing particles of the metal on the two
components and bonding the metal particles; and

 wherein providing the particles comprises providing the particles in a
foam and wherein bonding the metal particles comprises collapsing the foam.

21. A method of bonding two components, the method comprising:
positioning the components relative to one another to obtain a desired
orientation; and

5 bonding the two components in the desired orientation with metal
wherein a temperature of both components is maintained below a melting
temperature of the metal while bonding;

 wherein bonding comprises providing particles of the metal on the two
components and bonding the metal particles; and

10 wherein bonding the metal particles comprises introducing a liquid
species that amalgamates with the particles at a bonding temperature less
than the melting temperature of the metal.

22. A method according to Claim 21 wherein the metal comprises silver
15 and the liquid species comprises mercury.

23. A method of bonding two components, the method comprising:
positioning the components relative to one another to obtain a desired
orientation; and

20 bonding the two components in the desired orientation with metal
wherein a temperature of both components is maintained below a melting
temperature of the metal while bonding;

 wherein bonding comprises providing particles of the metal on the two
components and bonding the metal particles; and

25 wherein bonding the metal particles comprises corroding the metal
particles.

24. A method according to Claim 23 wherein corroding the metal
particles comprises oxidizing the metal particles.

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25. A method according to Claim 24 wherein corroding the metal
particles comprises galvanically corroding the metal particles.

26. A method of bonding two components, the method comprising:

positioning the components relative to one another to obtain a desired orientation; and

bonding the two components in the desired orientation with metal wherein a temperature of both components is maintained below a melting 5 temperature of the metal while bonding;

wherein bonding comprises providing particles of the metal on the two components and bonding the metal particles; and

wherein bonding the metal particles comprises applying pressure to the metal particles.

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27. A method of bonding two components, the method comprising:

positioning the components relative to one another to obtain a desired orientation; and

bonding the two components in the desired orientation with metal

15 wherein a temperature of both components is maintained below a melting temperature of the metal while bonding;

wherein bonding comprises providing particles of the metal on the two components and bonding the metal particles; and

wherein bonding the metal particles comprises plating a metal thereon.

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28. A method of bonding two components, the method comprising:

positioning the components relative to one another to obtain a desired orientation; and

bonding the two components in the desired orientation with metal

25 wherein a temperature of both components is maintained below a melting temperature of the metal while bonding;

wherein bonding comprises providing particles of the metal on the two components and bonding the metal particles; and

30 wherein bonding the metal particles comprises providing a solution of a second metal on the metal particles to initiate a displacement reaction.

29. A method of bonding two components, the method comprising:

providing particles of a metal on at least one of the components and vibrating the particles; then

positioning the components relative to one another to obtain a desired orientation wherein positioning the components comprises positioning the components while vibrating the particles; and

5 bonding the two components in the desired orientation with metal wherein a temperature of both components is maintained below a melting temperature of the metal while bonding wherein bonding the two components comprises ceasing vibrating the particles.

10 30. A method according to Claim 1 wherein a first one of the components comprises a substrate.

15 31. A method according to Claim 30 wherein a second one of the components comprises one of a micro-electronic component, a micro-optical component, or a micro-mechanical component.

32. A method according to Claim 30 wherein the substrate comprises one of a dam thereon or a well therein.

20 33. A method of bonding two components, the method comprising:
positioning the components relative to one another to obtain a desired orientation; and
bonding the two components in the desired orientation with metal wherein a temperature of both components is maintained below a melting temperature of the metal while bonding and wherein a temperature of the
25 metal is maintained below a melting temperature of the metal while bonding.

30 34. A metallically bonded structure comprising:
first and second components; and
a plurality of bonded metal particles providing bonding between the two components.

35. A structure according to Claim 34 wherein each of the metal particles comprises a dielectric material coated in the metal.

36. A structure according to Claim 34 wherein each of the bonded metal particles comprises a corroded layer thereon wherein the corroded layer of adjacent particles provides bonding therebetween.

5 37. A structure according to Claim 36 wherein the corroded layer comprises an oxide of the metal.

38. A structure according to Claim 36 wherein the corroded layer comprises a galvanically corroded layer.

10 39. A structure according to Claim 34 wherein the first component comprises a substrate.

15 40. A structure according to Claim 39 wherein the second component comprises one of a micro-electronic component, a micro-optical component, or a micro-mechanical component.

20 41. A structure according to Claim 34 wherein adjacent metal particles are bonded at interfaces therebetween with voids remaining between metal particles.

25 42. A structure according to Claim 41 wherein adjacent metal particles have a metal to metal contact at a bonding interface therebetween and wherein at least one of the metal particles comprises a dielectric layer on a portion thereof.

43. A structure according to Claim 34 wherein adjacent metal particles are bonded by layers of corrosion thereon.

30 44. A structure according to Claim 43 wherein the layers of corrosion comprise an oxide of the metal.

45. A structure according to Claim 43 where the layers of corrosion comprise galvanic corrosion.

46. A structure according to Claim 43 wherein the metal particles comprises a metal with high diffusion rate at room temperature.

5 47. A structure according to Claim 46 wherein the metal particles comprise indium.

10 48. A structure according to Claim 34 wherein the bonded metal particles comprises a first metal, the structure further comprising:

 a plated layer comprising a second metal between bonded metal particles wherein the second metal and the first metal are different.

15 49. A metallically bonded structure comprising:
 first and second components; and

 a metal layer between the first and second components wherein the metal layer provides bonding between the two components and wherein the metal layer extends onto a portion of the second component opposite the first component.

20 50. A structure according to Claim 49 wherein the metal layer comprises a plurality of bonded metal particles.

25 51. A structure according to Claim 49 wherein the metal layer includes dielectric particles therein.

 52. A structure according to Claim 49 wherein the metal layer comprises an amalgam.

30 53. A structure according to Claim 52 wherein the amalgam comprises silver and mercury.

 54. A structure according to Claim 49 wherein the first component comprises a substrate.

55. A structure according to Claim 54 wherein the second component comprises one of a micro-electronic component, a micro-optical component, or a micro-mechanical component.

5 56. A micro-structure comprising:
a substrate;
a micro-component positioned relative to the substrate; and
a plurality of metal particles adjacent both the substrate and the micro-component.

10 57. A micro-structure according to Claim 56 wherein the metal particles are bonded to one another.

15 58. A micro-structure according to Claim 56 wherein at least one of the metal particles comprises a dielectric material surrounded by a metal layer.

59. A micro-structure according to Claim 56 wherein at least one of the metal particles comprises a diffusion barrier thereon.

20 60. A micro-structure according to Claim 59 wherein at least one of the metal particles comprises a first metal having a first diffusion rate and wherein the diffusion barrier comprises a surface layer of a second metal having a second diffusion rate wherein the first diffusion rate is higher than the second diffusion rate.

25 61. A micro-structure according to Claim 59 wherein the diffusion barrier comprises a dielectric layer on the metal particle.

30 62. A micro-structure according to Claim 61 wherein the diffusion barrier comprises an oxide layer.

63. A micro-structure according to Claim 59 wherein the diffusion barrier comprises a layer of a material that sublimes at room temperature.

64. A micro-structure according to Claim 63 wherein the material that sublimes at room temperature comprises one of carbon dioxide or naphthalene.

5 65. A micro-structure according to Claim 56 wherein the metal particles comprise a metal that forms an amalgam when exposed to a dissimilar liquid metal species at a temperature less than the melting temperature of the metal.

10 66. A micro-structure according to Claim 65 wherein the metal comprises silver.

15 67. A micro-structure according to Claim 56 wherein the micro-component comprises one of a micro-electronic component, a micro-optical component, and/or a micro-mechanical component.